

SHOWCASE PROJECT: CELANESE CORPORATION: LARGE CHEMICAL PLANT IMPROVES ENERGY AND ENVIRONMENTAL PERFORMANCE WITH BOILER UPGRADE

SOLUTION OVERVIEW

The Celanese plant in Narrows, Virginia, originally began operation in December 1939. Today the plant produces cellulose acetate in flake and tow forms, and employs approximately 1,000 Celanese and contract personnel. High pressure steam generated from the steam boiler system is used in various parts of the process; however, the majority is sent through four turbine generators to generate electricity. This also reduces the steam to lower pressure which is then used in other process areas throughout the plant.

In March 2015, Celanese successfully completed a \$160 million boiler replacement project at this facility replacing coal-fired boilers with natural gas-fired boilers that were compliant with National Ambient Air Quality Standards (NAAQS) and the National Emission Standards for Hazardous Air Pollutants for Major Sources: Industrial, Commercial, and Institutional Boilers and Process Heaters (Boiler MACT) rule. In alignment with the U.S. Department of Energy (DOE) Better Plants Challenge partnership, Celanese implemented the replacement project with energy efficient boilers instead of simply replacing the existing boiler fleet with boilers of similar capacity.

The project resulted in the shutdown of seven coal-fired boilers and two older gas-fired boilers, substantially improving energy efficiency, reducing greenhouse gas emissions and solid waste. While the project was originally motivated by a need to comply with the Boiler MACT and NAAQS, this boiler upgrade project achieves energy savings that go beyond these mandates.

The new boiler system has significantly reduced energy demand at the site. With fewer components and a more efficient design, the new boilers have resulted in an estimated 12% reduced site electrical load, which yields total plant-wide annual energy savings of approximately 6% and energy cost savings of just under 19%. This is primarily achieved by the reduction of large, high-horsepower boiler fans and elimination of ancillary equipment such as pulverizers and coal and coal ash conveying and handling equipment. Because the new boilers operate at a positive furnace firebox pressure, whereas the coal-fired boilers required a negative working pressure, the boilers operate with fewer large horsepower combustion draft fans, which significantly reduce boiler electrical load.

Due to changes in required operating equipment, plant steam demand has also dropped by an estimated 6%. This reduction in steam demand largely resulted from the elimination of an existing boiler feed water heater, which is made possible by the installation of additional heat recovery systems and economizers on the new boilers and additional condensate recovery. The conversion was completed without a total plant outage.

Keeping the existing coal-fired boilers would have required significant and costly modifications to the existing steam system to be in compliance with Boiler MACT and NAAQS regulations. Beginning in 2011, Celanese scoped and developed a project for five new natural gas-fired boilers to replace the existing boiler system at the Narrows plant. In December of 2014, the first boiler was commissioned, with full commissioning of all five new boilers and shutdown of the old coal-fired boilers completed in March 2015.

SECTOR TYPE

Industrial

LOCATION

Virginia

PROJECT SIZE

57,280,000 Sq. Feet

FINANCIAL OVERVIEW

Project Cost: \$160,000,000

SOLUTIONS

Installing a complete new boiler system into a plant this size is a difficult operation. The project deliverables included the necessity that there would be no supply interruption, requiring that the new and existing systems had to be tied together without the plant being taken off-line. Also, since the old coal-fired boilers were to be taken out of service, the new system had to meet the expectation for high reliability immediately upon commissioning.

This was achieved through:

- New equipment and piping tie-in completion during opportunistic outages and regularly scheduled maintenance opportunities on the existing systems;
- Use of existing steam header piping;
- Operator training with a simulator, then in a mock control room on live boilers not tied to the operating steam systems;
- Technician training by conducting preventative maintenance (PM) work on the boilers prior to commissioning with oversight from vendor representatives;
- Extensive on-site classroom and in-plant training of maintenance and operations personnel;
- Piping & Instrument Diagram (P&ID) review, conceptual training and in-plant walkthroughs – conducted by the new boiler vendor;
- Full load controls testing (natural gas and fuel oil), trip testing, system checks and other tests during a one-month long systems commissioning;
- Back-up, ultra-low sulfur diesel fuel system which allows for three days of full load backup capability in case of natural gas supply disruption;
- Design for the ability to conduct maintenance on individual systems with capability to isolate individual sections without a complete shutdown;

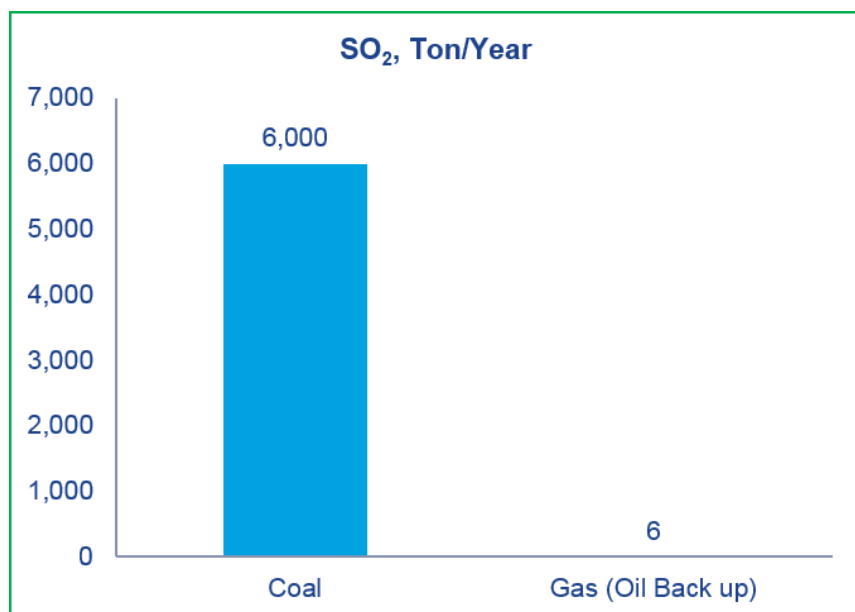
- Designed redundancy to eliminate high consequence, single points of failure;
- On-schedule installation of a new 15-plus mile natural gas transmission line from the Columbia Gas transmission “KA” line in West Virginia to the Narrows site which increased tenfold the supply of natural gas to the site.

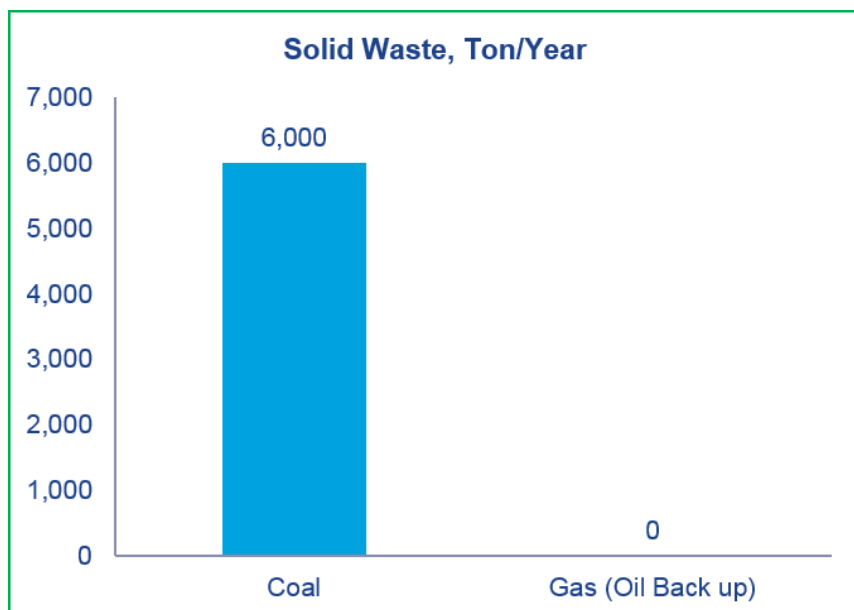
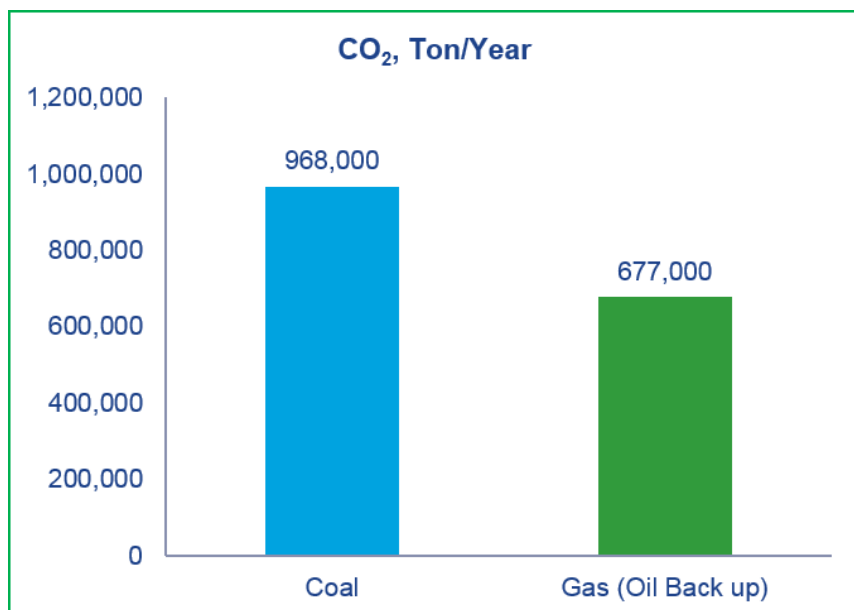
Celanese invested \$160 million to replace its coal-fired boilers with natural gas-fired boilers to generate the steam needed to run the plant’s electrical generators and plant processes.

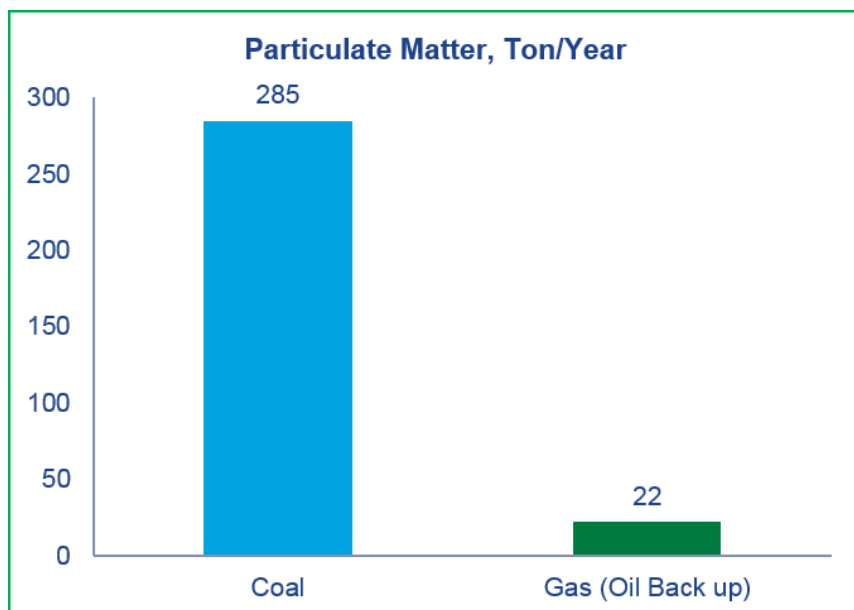
OTHER BENEFITS

An important non-energy benefit of this system is the positive environmental impact. The new boiler installation has reduced the sites baseline emissions of NO_x, greenhouse gas emissions, SO₂, particulate matter, and generation of solid waste. Specific environmental benefits include:

- SO₂ emissions are reduced 99% from 6,000 ton/yr. to 6 ton/yr.
- CO₂ emissions are reduced 30% from 968,000 ton/yr. to 677,000 ton/yr.
- NO_x emissions are reduced 91% from 3,576 ton/yr. to 300 ton/yr.
- Particulate matter is reduced 92% from 285 ton/yr. to 22 ton/yr.
- The solid waste footprint of the site will be reduced by at least 75%. Solid waste generated by the boilers will be eliminated entirely, a reduction of 60,000 ton/yr.







In addition, the project improved operating reliability due to:

- A simpler improved design;
- Operating with available excess capacity to allow for continued operation in the event of a single failure;
- A significant reduction in the amount of ancillary equipment that needed to be maintained such as coal feeders, ash systems and pulverizers.

This improved operational reliability is yielding approximately 2% reduced maintenance and operating costs per year.

Also by switching from 30 days of coal inventory to three days of backup diesel fuel inventory, a reduction of working capital will occur. The elimination of coal and coal-fired boiler by-products also improves housekeeping and overall plant condition, reduces storm water impact of handling ash and coal, and eliminates spill potential and maintenance concerns with the bottom (wet) ash system. The new boiler system also has occupational safety and health and process safety benefits which include:

- Elimination of coal dust in operating area;
- Elimination of fire hazards associated with coal storage;
- Ensures compliance with current Recognized and Generally Accepted Good Engineering Practices (RAGAGEP) for burner management systems, and Celanese Engineering Standards for Safety Instrumented Systems and Mechanical Integrity;
- Elimination of several operational tasks with associated ergonomic and industrial hygiene risk factors (ash removal, coal handling).

Annual Energy Use

(Source EUI)

Baseline()



Actual()



Energy Savings

6%

Annual Energy Cost

Baseline()



Actual()



Cost Savings

19%



New gas boilers



TOW lines at Celanese Narrows Plant



Aerial View - Celanese Narrows, Virginia Plant